

INTEGRATED COOLANT CONDUCTIONFOR A COMPUTER TOMOGRAPH

[0001] The invention relates to a support cradle or stand for a computed tomography system as generically defined by the preamble to claim 1. The invention also relates to a computed tomography system having such a support cradle or stand. A computed tomography system is an apparatus for generating a three-dimensional image of an object being examined, in particular a patient, using radiological diagnostic methods.

[0002] A conventional computed tomography system, of the kind known for instance from European Patent Disclosure EP 0 292 690 A1, includes a rotating body with a central opening, into which the object being examined is pushed. The rotating body includes an X-ray emitter for passing X-radiation through the object being examined, and an X-ray detector, diametrically opposite the X-ray emitter, for making an X-ray image. The rotating body is supported rotatably on a support cradle, so that by rotating the rotating body, the object being examined can be exposed to radiation from many directions. From the information in the X-ray images thus made, the three-dimensional image of the object being examined is then created, using electronic data processing.

[0003] A problematic aspect of such computed tomography systems is particularly the dissipation of the heat that occurs in the X-ray emitter and the X-ray detector. Local air cooling, for instance by means of a fan, can be used only to a limited extent if at all in a computed tomography system, especially since the draft necessarily created is unwanted for health reasons. Supplying and evacuating a gaseous or liquid coolant using rigid or flexible coolant lines cannot be done either, or can be done only in a complicated and expensive way, especially since such lines must not hinder the required rotatability of the rotating body.

[0004] For this reason, a computed tomography system is often equipped with a complex cooling system. For instance, from the aforementioned EP 0 292 690 A1, a computed tomography system is known in which a first cooling loop is provided for cooling the X-ray emitter. The first cooling loop exchanges the absorbed heat with

a second cooling loop, which is placed partly in an annular chamber formed between the rotating body and the support cradle. Cooling air flows through the annular chamber, and this cooling air is itself cooled by means of a fourth cooling loop, which in particular is water-driven.

[0005] From German Patent Disclosure DE 42 17 874 A1, a mobile radiological diagnostic system is also known, in which an X-ray emitter and an X-ray detector are secured, diametrically opposite one another, on a support cradle that includes a C-arch. For cooling the X-ray emitter, a double hose is provided, which extends partly inside the support cradle.

[0006] The object of the invention is to disclose a support cradle for a computed tomography system, with suitable cooling conduction, that at the same time is easily implemented. It is also the object of the invention to disclose a computed tomography system with a suitable and at the same time easily implemented cooling device.

[0007] With respect to the support cradle, this object is attained according to the invention by the characteristics of claim 1. According to this claim, a support cradle for the rotating body of a computed tomography system is embodied at least partly as a hollow section. The hollow chamber embodied in the support cradle is used as a conduit for supplying or evacuating a coolant. With regard to the computed tomography system, the object is attained according to the invention by the characteristics of claim 10.

[0008] By integrating at least part of the line system of the cooling device with the support cradle for a computed tomography system, a compact and advantageous layout of the lines is attained. In particular, because the coolant is carried in the interior of the support cradle, a freely suspended line is avoided, thus improving the manipulation of the computed tomography system and reducing the vulnerability of the cooling device to malfunction. Integrating the coolant layout with the support cradle is moreover structurally simple and is uncomplicated and inexpensive to attain. A support cradle embodied at least partly as a hollow section, finally, is advantageous in view of its comparatively low weight with high stability.

[0009] In a preferred embodiment, the support cradle is embodied such that in its interior, two hollow chambers extending essentially parallel and fluidically separated from one another are embodied. A first of these hollow chambers is used as a conduit for supplying the coolant, where the second hollow chamber is embodied as a conduit for evacuating the coolant.

[0010] The support cradle expediently includes a pedestal with two vertical supports. In addition, the support cradle expediently includes a supporting ring, which is rotatably supported between the vertical supports about a horizontal transverse axis. The supporting ring of the construction, which because it is suspended on both sides is also known as a "gantry," in turn serves to support a rotating body or carriage.

[0011] The pedestal of the support cradle expediently includes a base plate, embodied as a hollow section, in which at least one but preferably two transversely extending hollow chambers fluidically separated from one another are embodied, which are used as transverse conduits for the coolant. Via these transverse conduits, a blower and cooling unit can be especially expediently connected and in a space-saving way is preferably disposed on the base plate.

[0012] Alternatively or in addition, the supporting ring of the support cradle is embodied as a hollow section, so that in the interior of the supporting ring, at least one but preferably two annular hollow chambers, separated from one another, are embodied as an annular conduit for the coolant. In a stable and structurally simple geometrical configuration, the supporting ring has a substantially L-shaped profile, and one annular conduit is disposed in each arm of the L-shaped section.

[0013] Supplying or evacuating the coolant from an annular conduit of the supporting ring is expediently done via the transverse axis about which the supporting ring is rotatably supported, so that the supply and evacuation of the coolant are independent of the rotary position of the supporting ring. For the sake of the coolant layout, a shaft segment secured to the circumference of the supporting ring is embodied in hollow form and communicates with the corresponding annular conduit of the supporting ring.

[0014] Each annular conduit corresponds, via a number of openings that are made along the respective conduit course in an inner wall of the supporting ring adjacent to the rotating body, with the gap between the rotating body and the supporting ring, or with a corresponding line system inside the rotating body. Thus, the coolant from the first annular conduit flows through at least one of the aforementioned openings into the aforementioned gap or into a coolant supply line of the rotating body. The heated coolant is conducted, optionally via a coolant evacuation line of the rotating body, to the inner wall of the supporting ring and is evacuated, through at least a further one of the aforementioned openings, into the second annular conduit of the supporting ring. If the evacuation of the heated coolant is done from a coolant evacuation line of the rotating body, then the openings in the supporting ring are distributed over the circumference of the supporting ring, expediently corresponding with the coolant evacuation line. Thus in an especially simple way, a supply of coolant from the supporting ring to the rotating body and an evacuation of coolant from the rotating body into the supporting ring are attained, regardless of the current rotary position of the rotating body.

[0015] For good separation between the supply and the evacuation of the coolant and for a structurally simple line layout, it is advantageous if the first annular conduit discharges axially into the rotating body with respect to the supporting ring via the aforementioned openings, while the second annular conduit discharges radially into the rotating body with respect to the supporting ring, or conversely if the second annular conduit discharges axially into the rotating body with respect to the supporting ring, while the first annular conduit discharges radially into the rotating body.

[0016] The transverse and annular conduits described are especially highly suitable, for instance because of the large attainable conduit cross section, for achieving air cooling. Alternatively, however, a liquid can also be used as the coolant.

[0017] Further advantageous features of the invention will become apparent from the dependent claims.

[0018] Exemplary embodiments of the invention will be described in further detail below in conjunction with drawings. In the drawings:

[0019] Fig. 1, in a schematic view, shows a support cradle, formed from a pedestal and a supporting ring, and a rotating body, rotatably supported on the supporting ring, as well as a cooling device for an X-ray emitter disposed in the rotating body;

[0020] Fig. 2 shows the pedestal in perspective;

[0021] Fig. 3 shows the pedestal of Fig. 2, in a perspective view that is rotated relative to Fig. 2;

[0022] Fig. 4 shows the supporting ring of Fig. 1 in perspective; and

[0023] Fig. 5 is a schematic cross section V-V through the supporting ring of Fig. 4 along with a rotating body mounted in it.

[0024] Elements and sizes corresponding to one another are identified by the same reference numerals throughout the drawings.

[0025] In Fig. 1, a computed tomography system 1 is shown in a schematic sketch. The key part of the computed tomography system 1 is a rotating body 2.

[0026] The rotating body 2 is penetrated by a central opening 3, into which an object to be examined (not further shown) can be pushed. In the usual medical application of a computed tomography system, the object to be examined is a patient to be examined.

[0027] The rotating body 2 includes an X-ray emitter 4 and, opposite it, an X-ray detector 5. The X-ray emitter 4 is disposed such that X-radiation R can be passed through the object to be examined, located in the opening 3. An X-ray image made by means of the X-ray detector 5 is supplied, in operation of the computed tomography system 1, to an electronic evaluator (not shown), in particular a computer.

[0028] For generating a three-dimensional image of the object to be examined, the rotating body 2 is rotatable about an axis 6 that is perpendicular to the plane of

Fig. 1, and is thus rotatable in the direction of the arrow 7. In this way, the object to be examined can be X-rayed from many directions. From the X-ray images made for different exposure directions, a three-dimensional image of the object being examined is then generated in the electronic evaluator, using mathematical methods.

[0029] The rotating body 2 is supported by a support cradle 8. The support cradle 8 includes a pedestal 9 and a gantry 10. The pedestal 9 includes a horizontal base plate 11, from which two struts 13, spaced apart in a transverse direction 12, protrude approximately at a right angle and hence vertically.

[0030] The gantry 10 is provided with two shaft segments 15a, 15b, aligned with one another and each protruding from the outer circumference 14 of the gantry 10. Each shaft segment 15a, 15b is located in a corresponding guide 16 (Figs. 2 and 3) on the associated strut 13, so that on the pedestal 9, the gantry 10 is rotatably supported about a horizontal transverse axis 17. The gantry 10 in turn rotatably supports the rotating body 2 about the common axis 6.

[0031] In operation of the computed tomography system, the X-ray emitter 4 in particular becomes quite hot. Further lost heat occurs to a lesser extent in the X-ray detector 5 as well. For dissipating this lost heat from the rotating body 2, the computed tomography system is equipped with a cooling device 18. The cooling device 18 includes a blower and cooling unit 19, which blows cooled air L as coolant into a supply line 20 (indicated by a dashed-line arrow). The supply line 20 is initially guided, in a manner to be described in further detail below, by the base plate 11 of the pedestal 9. From one transverse end 21 of the base plate 11, the supply line is extended, via a hose connection or the like (not shown) and a hollow shaft segment 15a, into the interior of the gantry 10. From there, the supplied air L is supplied to a supply line 20' of the rotating body 2, which line discharges into a heat exchanger 22 disposed in the rotating body 2.

[0032] In the heat exchanger 22, the supplied air L is put into thermal contact with a primary cooling circuit 23, in the course of which the X-ray emitter 4 (and optionally the X-ray detector 5 as well, in a way that is not explicitly described) is disposed. The cooling circuit 23 includes a coolant liquid F, which flows around the

outside or partly flows through the X-ray emitter 4. The coolant liquid F heated in the X-ray emitter 4 is cooled in the heat exchanger 22 by means of the cool air L supplied. The air L heated in the process is returned to the blower and cooling unit 19 via an evacuation line 24 (represented by a dotted arrow).

[0033] From the heat exchanger 2, the heated air L is supplied in the course of the evacuation line 24 to the gantry 10 (the part of the evacuation line 24 associated with the rotating body 2 is designated here as 24'). Inside the gantry 10, the air L is supplied to the shaft segment 15b, in a manner to be described in further detail below. From there, the air L is brought via a hose connection or the like (not shown in further detail here) to the transverse end 25 of the base plate 11, diametrically opposite the transverse end 21. Through the interior of the base plate 11, the air L is then again supplied to the blower and cooling unit 19.

[0034] The air loop formed by the supply line 20, 20' and the evacuation line 24, 24' is thus closed, so that the development of a draft, which is unwanted for health reasons, as a consequence of the recirculation of the air L is avoided.

[0035] Figs. 2 and 3 show the pedestal 9 of the computed tomography system 1 in perspective, from different viewing angles. Particularly from Fig. 3, it can be seen that the base plate 11 is embodied as a hollow section, especially of sheet metal. In the interior of the base plate 11, a series of hollow chambers 26a through 26d is formed, extending in the longitudinal direction 12. The hollow chamber 26a is used here as a conduit 27 for evacuating the air L from the blower and cooling unit 19, and thus is used as part of the supply line 20. For this purpose, the hollow chamber 26a communicates with the outlet stub (not shown) of the blower and cooling unit 19. In the same way, the hollow chamber 26d is used as a transverse conduit 28 for returning the heated air L to the blower and cooling unit 19, and thus is used as part of the evacuation line 24. The transverse conduit 28 communicates for this purpose with the inlet stub (not shown) of the blower and cooling units 19.

[0036] In Fig. 4, the gantry 10 is shown in perspective. A schematic cross section, which in particular is not to scale, along the line V-V through the gantry 10 and the rotating body 2 mounted in it is shown in Fig. 5. As can be seen from Figs.

4 and 5, the gantry 10 is embodied as an annularly closed hollow section. The L-shaped section of the gantry 10 has a radial arm 29, from whose radially outer end an axial arm 30 extends approximately at a right angle. In each of the two arms 29 and 30, there is a respective hollow chamber 31a and 31b, which are fluidically separated from one another and are used as annular conduits 32 and 33, respectively, for supplying and evacuating the air L. The annular conduit 32 disposed in the region of the radial arm 29 serves to supply the air L to the rotating body 2 and thus is a component of the supply line 20.

[0037] For supplying the air L, the annular conduit 32 communicates with a duct 34 through the hollow shaft segment 15a. Via a number of openings 35, which are made in the inner wall 36 of the gantry 10, facing toward the rotating body 2, in the region of the annular conduit 32, the annular conduit 32 corresponds with the supply line 20' of the rotating body 2. Thus, the annular conduit 32 discharges in the axial direction into the supply line 20' of the rotating body 2. The openings 35 are disposed in a circle around the axis 6, so that for every rotary position of the rotating body 2 relative to the gantry 10, at least one opening 35 overlaps an inlet 37 of the supply line 20', and in this way the supply of air to the rotating body 2 is assured, regardless of the rotary position of the rotating body.

[0038] The annular conduit 33 serves to return the air L from the rotating body 2 and is thus a component of the evacuation line 24. The return of the air L from the rotating body 2 into the annular conduit 33 is effected via a number of openings 38, which are made in the axially oriented part of the inner wall 36, in the region of the annular conduit 33. The annular conduit 33 thus discharges in a radial direction into the evacuation line 24' of the rotating body 2. The openings 38 are distributed over the inside circumference of the gantry 10 at the same axial height of the supporting ring, so that for every rotary position of the rotating body 2 relative to the gantry 10, at least one opening 38 overlaps an outlet 39 of the evacuation line 24', and thus the evacuation of the air L from the rotating body 2 is also assured regardless of the rotary position of the rotating body 2. The annular conduit 33 opens, for evacuating the air L, toward a duct 40 of the hollow shaft segment 15b.

[0039] In an alternative, advantageously simplified embodiment, the rotating body 2 has no cooling device of its own in the form of a supply line for cold coolant and an evacuation line for heated coolant. Instead, the coolant is conducted through the gap between the rotating body 2 and the gantry 10. Cooling of the rotating body 2 takes place in this embodiment via the radial outer side of the rotating body 2, which for this purpose has good heat exchange properties or is equipped with heat exchanging devices.